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Noise Attenuation Performance of the David Clark H10-76 Headset with and without the M53 Hood

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Noise attenuation performance was measured on the David Clark H10-76 headset and the M53 hood at the Air Force Research Laboratory's (AFRL) Acoustics facilities at Wright-Patterson Air Force Base in August 2014. American National Standards Institute (ANSI) S12.42-2010 was used to measure the passive insertion loss performance of the systems. The objective of this study was to measure the noise attenuation performance and determine if the performance requirements were met as defined in the performance specification. The addition of the M53 hood to the headset degraded the noise attenuation performance by more than 3 dB across all frequencies when compared to the David Clark H10-76 headset alone using the objective (ANSI S12.42) passive insertion loss measurements.

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EXECUTIVE SUMMARY

Noise attenuation performance measurements were collected on the David Clark H10-76 headset with and without the M53 hood at the Air Force Research Laboratory's (AFRL) acoustics facilities at Wright-Patterson Air Force Base in August 2014. American National Standards Institute (ANSI) S12.42-2010[1] Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear (MIRE) or Acoustic Test Fixture Procedures was used to measure the passive insertion loss of the headset with and without the M53 hood. The performance specification requirement defined that when integrated, no more than a 3 dB degradation of the measured one-third octave band hearing attenuation shall result when compared to the original (headset only) configuration. The results showed that the addition of the M53 hood degraded the noise attenuation of the headset by more than 3 dB across all frequencies from 125 to 8000 Hz.

1.0 INTRODUCTION

The M53 hood, shown in Figure 1 below, provides "above-the-shoulder" chemical/biological (CB) protection for the respiratory system in an actual or perceived CB warfare environment. The M53 is programmed for utilization in United States Air Force, United States Navy, United States Marine Corp, and United States Coast Guard strategic aircraft. The system was designed to be worn with all the current below-the-neck ensembles. Air and ground crewmembers don the M53 hood based on current threat and operational requirements. Personnel also perform extended ground duties such as pre-flight, post-flight, rearming, refueling and cargo loading of aircraft while wearing the M53 hood and emergency actions such as ground escape and evasion. This system was developed to replace the currently used protective mask. The David Clark H10-76 headset (Figure 2), a typical headset worn by aircraft maintainers and flight crews, was tested with the M53. The headset has active noise reduction (ANR) capabilities. However, ANR was not assessed during these measurements; the measurements were passive performance only.

Figure 1. Person wearing M53 (left) and schematic drawing of M53 (right)

Figure 2. David Clark H10-76 Headset

2.0 METHODS

2.1 Subjects

Ten paid volunteer subjects (6 male, 4 female) participated in the attenuation measurements on the David Clark H10-76 headset worn with and without the M53 hood (Figure 3). The ten subjects ranged in age from 18 to 34 with a mean age of 21 years. All subjects were expertly fitted by a trained program representative. The hood size distribution was as follows: two subjects were fitted with size large, five subjects were fitted with size medium, and three subjects were fitted with size small.

Figure 3. Subject wearing David Clark H10-76 headset (left) and subject wearing David Clark H10-76 headset with the M53 hood (right) for MIRE measurement

2.2 Passive Insertion Loss Measurements

The AFRL MIRE facility was used to measure the passive insertion loss of hearing protectors (Figure 4). Insertion loss was defined as the algebraic difference in dB between the sound pressure levels (SPL) measured at a reference point with and without the hearing protection device in place. The facility and measurements were operated in accordance with ANSI S12.42-2010. [1] Miniature microphones (Knowles model BT-1759) were used to simultaneously measure the SPL at the entrance of both ear canals. 115 dB overall SPL was generated and two objective measurements were collected to complete one trial: open ear and occluded ear. Three trials were collected per subject. For each subject, the mean insertion loss of the three trials was computed. Average insertion loss for the ten subjects was then calculated for each configuration.

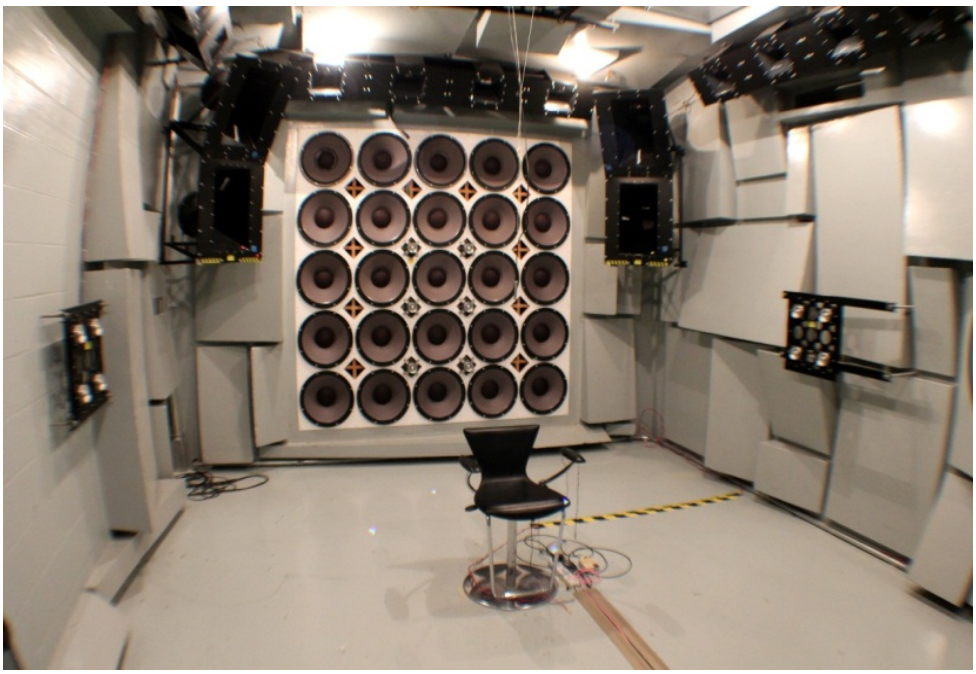

Figure 4. MIRE facility at AFRL

3.0 RESULTS

ANSI S12.42 measurements of the David Clark H10-76 headset were collected with and without the M53 hood (Table 1, Figure 5). The results were analyzed to compare the noise attenuation performance of the headset with and without the M53 hood in order to understand the effect the hood has on the noise attenuation performance of the headset. The requirement states that the addition of the M53 hood shall not degrade the noise attenuation of the headset by more than 3dB.

3.1 MIRE – Passive Insertion Loss

Passive insertion loss data were collected in the MIRE facility at AFRL on David Clark H10-76 headset (passive only, no ANR) with and without the M53 hood. Mean and standard deviation data from 125-8000 Hz are shown numerically in Table 1 and graphically in Figure 5. The addition of the M53 hood degraded the noise attenuation greater than 3 dB across all frequencies.

Table 1. Mean passive insertion loss results from MIRE measurements comparing the David Clark H10-76 headset with and without the M53 hood

		Frequency (Hz)						
		125	250	500	1000	2000	4000	8000
DC H10-76 headset only	Mean	7.6	120	17.9	25.3	30.2	36.5	39
	SD	2.2	2.5	3.4	4.8	4.6	5.7	3.4
DC H10-76 headset/M53	Mean	-2.0	-0.8	2.6	6.7	15.0	23.6	23.2
	SD	1.4	2.0	3.4	2.8	3.7	6.3	5.1

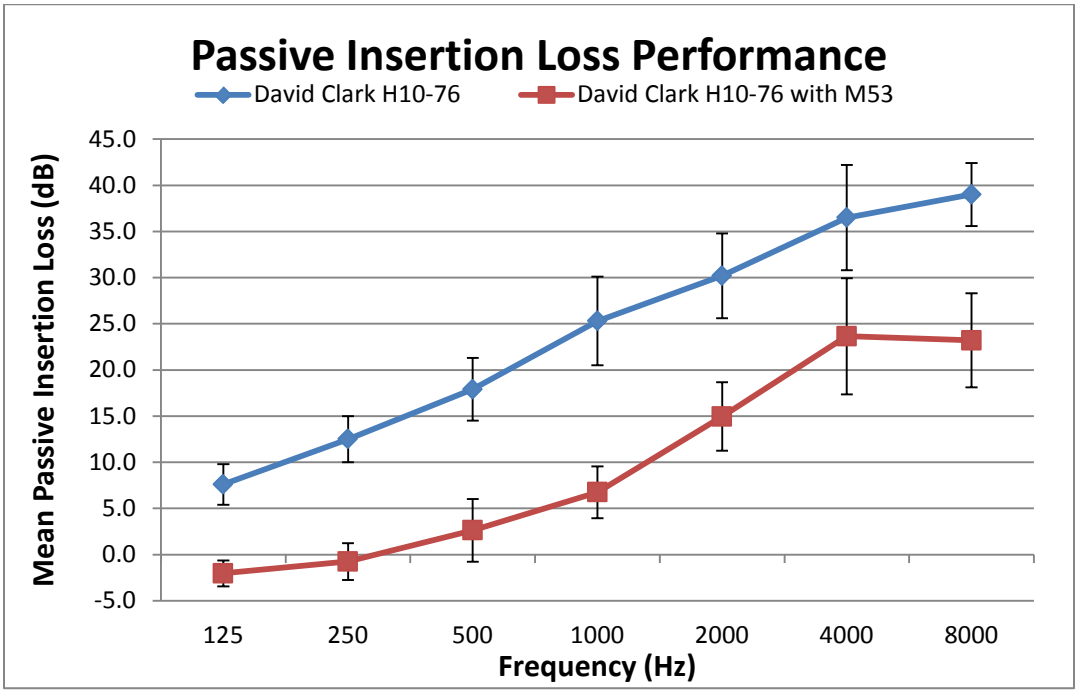

Figure 5. Passive insertion loss of the David Clark H10-76 with and without the M53 hood

4.0 DISCUSSION

It is well known that the noise attenuation performance of a headset may be degraded when worn in combination with a CB hood like the M53. Any material or cable that breaks the seal of an earcup in a headset or helmet has the potential to create an acoustic leak. The requirement was set so that the M53 hood, worn in combination with a headset such as the David Clark H10-76, would degrade the noise attenuation performance of the headset by no more than 3 dB across all frequencies when compared to the headset alone.

ANSI S12.42 methods were used to collect passive insertion loss data for the David Clark H10-76 headset. The headset has ANR capability; however, the measurements were conducted with the ANR powered off for the passive performance only. It is clear from the results that the passive performance of the headset is severely degraded by the addition of the M53 hood, therefore it was not deemed productive to evaluate the active capabilities of the headset. ANSI S12.42 methods are objective measurements and were developed for engineering controls and product development/assurance. When comparing the performance of the David Clark H10-76 headset with and without the M53 hood, the M53 negatively affects the noise attenuation performance at all frequencies by more than 3 dB.

Recommended solutions to the attenuation requirement would be to add communication earplugs under the headset/hood, or to incorporate the earcup into the design of the hood. These hearing protection configurations have the potential to provide the necessary noise attenuation and communication needs when the M53 hood is required by personnel. Noise attenuation and speech intelligibility measurements must be conducted to understand the performance capabilities.

5.0 CONCLUSIONS

Passive insertion loss data were collected on the David Clark H10-76 headset with and without the M53 hood. The M53 hood degraded the attenuation by more than 3 dB across all frequencies, and therefore does not meet the performance specification requirement in this configuration.

6.0 REFERENCES

1. ANSI S12.42-2010 Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures